

Application No. 10/692,125  
Response to Office Action

Customer No. 01933

**Listing of Claims:**

1. (Currently Amended) A semiconductor light emitting device comprising:

a semiconductor substrate formed from InP;

an active layer which is formed from InGaAsP and provided at  
5 the an upper side of the semiconductor substrate, and which has  
a width of not less than 3.5  $\mu$ m; and

an n-type cladding layer formed from InGaAsP and a p-type cladding layer formed from InP, which ~~are formed so as to~~ hold the active layer therebetween,

10 wherein ~~, the semiconductor light emitting device is,~~ given that a refractive index of the n-type cladding layer is  $n_a$ , and a refractive index of the p-type cladding layer is  $n_b$ , ~~set so as to be the~~ a relationship of  $n_a > n_b$  in which the refractive index  $n_a$  of the n-type cladding layer is higher than the refractive index  
15  $n_b$  of the p-type cladding layer is satisfied, and ~~due to the~~ wherein a distribution of light generated by the active layer being is deflected to the n-type cladding layer side, such that optical loss by intervalence band light absorption at the p-type cladding layer is suppressed, ~~, and high power light output can~~  
20 ~~be obtained.~~

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2. (Currently Amended) A semiconductor light emitting device according to claim 1, ~~wherein the semiconductor light emitting device further comprises~~ comprising:

5 a first SCH (Separate Confinement Heterostructure) layer formed from InGaAsP, which is formed between the active layer and the n-type cladding layer; and

a second SCH layer formed from InGaAsP, which is formed between the active layer and the p-type cladding layer.

Claim 3 (Canceled).

4. (Currently Amended) A semiconductor light emitting device according to claim 1, wherein the active layer ~~includes~~ comprises a plural-layer MQW (Multi-quantum well) structure ~~having~~ including plural-layer well layers and plural-layer barrier layers positioned at ~~the~~ both sides of the respective well layers ~~at the plural-layer well layers~~.

5

5. (Original) A semiconductor light emitting device according to claim 2, wherein the first SCH layer includes a multilayer structure formed from a plurality of layers, and the second SCH layer includes a multilayer structure formed from a plurality of layers.

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6. (Currently Amended) A semiconductor light emitting device according to claim 5, wherein, given that a refractive index of a layer having the a lowest refractive index of said plurality of layers structuring in the active layer is  $n_s$ , and  
 5 given that respective refractive indices and thickness  
thicknesses of said plurality of layers of the first SCH layer are respectively  $n_1, n_2, n_3, \dots, n_N$  and  $t_1, t_2, t_3, \dots, t_N$ , an at  
order close increasing from the active layer, and given that  
respective refractive indices and thickness thicknesses of said  
 10 plurality of layers of the second SCH layer are respectively  $n_1, n_2, n_3, \dots, n_N$  and  $t_1, t_2, t_3, \dots, t_N$ , in an at order close  
increasing from the active layer,

~~the relationship of the thickness~~ thicknesses of the  
 respective layers is of both the first and second SCH layers are  
 15 set to be satisfy a relationship:

$$t_1 = t_2 = t_3 =, \dots, = t_N$$

~~the relationship of the magnitudes of the refractive indices~~  
 of the respective layers of the active layer, the first SCH  
layer, the second SCH layer, the n-type cladding layer and the p-  
 20 type cladding layer is set to ~~be the~~ satisfy a relationship:

$$n_s > n_1 > n_2 > n_3 >, \dots, n_N > n_a > n_b$$

such that the refractive indices of the first and second SCH  
layers become smaller ~~the further away~~ with increasing  
distance from the active layer, ~~and including the relationship~~

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25 ~~that the refractive index  $n_s$  of the active layer is the highest,~~  
~~and the refractive index  $n_a$  of the n-type cladding layer is~~  
~~higher than the refractive index  $n_b$  of the p-type cladding layer,~~  
and

differences between the refractive index differences between  
30 the indices of adjacent layers which are adjacent to one another  
in said plurality of layers respectively structuring the first  
SCH layer and the second SCH layer are set to ~~be the~~ satisfy a  
relationship:

$$n_s - n_1 > n_1 - n_2 > n_2 - n_3 > \dots > n_N - n_b > n_N - n_a$$

35 such that the differences between the refractive index  
differences indices become smaller ~~the further toward~~ with  
decreasing distance from the corresponding one of the n-type  
cladding layer and the p-type cladding layer and increasing  
distance from the active layer.

7. (Currently Amended) A semiconductor light emitting  
device according to claim 5, wherein, given that a refractive  
index of a layer having ~~the a~~ a lowest refractive index ~~of said~~  
~~plurality of layers structuring in~~ the active layer is  $n_s$ , ~~the~~  
5 given that respective refractive indices and ~~the thickness~~  
thicknesses of said plurality of layers of the first SCH layer  
are ~~respectively~~  $n_1, n_2, n_3, \dots, n_N$  and  $t_1, t_2, t_3, \dots, t_N$ , an at  
order ~~close~~ increasing from the active layer, and given that

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10 respective refractive indices and ~~the thickness~~ thicknesses of  
said plurality of layers of the second SCH layer are ~~respectively~~  
n1, n2, n3, ..., nN and t1, t2, t3, ..., tN, in an ~~at~~ order ~~close~~  
increasing from the active layer,

15 ~~the relationship of the magnitudes of the refractive indices~~  
~~of the respective layers~~ of the active layer, the first SCH  
layer, the second SCH layer, the n-type cladding layer and the p-  
type cladding layer is set to ~~be the~~ satisfy a relationship:

$$n_s > n_1 > n_2 > n_3 > \dots, n_N > n_a > n_b$$

such that the refractive indices of the first and second SCH  
layers become smaller ~~the further away with increasing~~  
20 distance from the active layer, ~~including the relationship that~~  
~~the refractive index ns of the active layer is the highest, and~~  
~~the refractive index na of the n-type cladding layer is higher~~  
~~than the refractive index nb of the p-type cladding layer,~~

25 differences between the refractive index ~~differences between~~  
~~the indices of adjacent~~ layers ~~which are adjacent to one another~~  
in said plurality of layers respectively structuring the first  
SCH layer and the second SCH layer are set to ~~be the~~ satisfy a  
relationship:

$$n_s - n_1 = n_1 - n_2 = n_2 - n_3 = \dots, = n_N - n_b$$

30 ~~(where  $n_N - n_b > n_N - n_a$ ),~~ where  $n_N - n_b > n_N - n_a$   
~~such that the refractive index differences are equal to one~~  
~~another, and~~

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~~the relationship of the thickness~~ thicknesses of the  
respective layers is of both the first and second SCH layers are  
35 set to ~~be~~ satisfy a relationship:

$$t1 < t2 < t3 < \dots < tN$$

such that the ~~thickness becomes~~ thicknesses become larger the  
~~further away with increasing distance~~ from the active layer.

8. (Currently Amended) A semiconductor light emitting  
device according to claim 5, wherein, given that a refractive  
index of a layer having ~~the a~~ lowest refractive index of ~~said~~  
~~plurality of layers structuring in~~ the active layer is  $n_s$ , the  
5 given that respective refractive indices and ~~the thickness~~  
thicknesses of said plurality of layers of the first SCH layer  
are respectively  $n_1, n_2, n_3, \dots, n_N$  and  $t_1, t_2, t_3, \dots, t_N$ , an at  
order close increasing from the active layer, and given that  
respective refractive indices and ~~the thickness~~ thicknesses of  
10 said plurality of layers of the second SCH layer are respectively  
 $n_1, n_2, n_3, \dots, n_N$  and  $t_1, t_2, t_3, \dots, t_N$ , in an at order close  
increasing from the active layer,

~~the relationship of the~~ magnitudes of the refractive indices  
of the respective layers of the active layer, the first SCH  
15 layer, the second SCH layer, the n-type cladding layer and the p-  
type cladding layer is set to ~~be the~~ satisfy a relationship:

$$n_s > n_1 > n_2 > n_3 > \dots > n_N > n_a > n_b$$

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such that the refractive indices of the first and second SCH layers become smaller ~~the further away with increasing~~  
20 distance from the active layer, ~~including the relationship that~~  
~~the refractive index  $n_s$  of the active layer is the highest, and~~  
~~the refractive index  $n_a$  of the n-type cladding layer is higher~~  
~~than the refractive index  $n_b$  of the p-type cladding layer,~~

differences between the refractive index ~~differences between~~  
25 ~~the indices of adjacent layers which are adjacent to one another~~  
in said plurality of layers respectively structuring the first  
SCH layer and the second SCH layer are set to ~~be the~~ satisfy a  
relationship:

$$n_s - n_1 > n_1 - n_2 > n_2 - n_3 > \dots > n_N - n_b > n_N - n_a$$

30 such that the differences between the refractive index  
differences indices become smaller ~~the further away with~~  
increasing distance from the active layer, and

~~the relationship of the thickness~~ thicknesses of the  
respective layers ~~is of both the first and second SCH layers are~~  
35 set to ~~be~~ satisfy a relationship:

$$t_1 < t_2 < t_3 < \dots < t_N$$

such that the ~~thickness becomes~~ thicknesses become larger ~~the~~  
~~further away with increasing distance~~ from the active layer.

9. (Currently Amended) A semiconductor light emitting  
device according to claim 5, wherein, given that a refractive

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index of a layer having ~~the a~~ lowest refractive index ~~of said~~  
~~plurality of layers structuring in~~ the active layer is  $n_s$ , and  
 5 ~~given that respective~~ refractive indices and ~~thickness~~  
~~thicknesses~~ of said plurality of layers of the first SCH layer  
 are ~~respectively~~  $n_1, n_2, n_3, \dots, n_N$  and  $t_1, t_2, t_3, \dots, t_N$ , ~~an at~~  
 order ~~close~~ increasing from the active layer, and ~~given that~~  
~~respective~~ refractive indices and ~~thickness~~ thicknesses of said  
 10 plurality of layers of the second SCH layer are ~~respectively~~  $n_1,$   
 $n_2, n_3, \dots, n_N$  and  $t_1, t_2, t_3, \dots, t_N$ , ~~in an at~~ order ~~close~~  
increasing from the active layer,

~~the relationship of the thickness~~ thicknesses of the  
 respective layers ~~is of both the first and second SCH layers are~~  
 15 set to be satisfy a relationship:

$$t_1 = t_2 = t_3 =, \dots, = t_N$$

~~the relationship of the~~ magnitudes of the refractive indices  
 of the respective layers of the active layer, the first SCH  
layer, the second SCH layer, the n-type cladding layer and the p-  
 20 type cladding layer is set to be ~~the relationship~~ satisfy  
relationships:

$$n_s > n_1 > n_2 > n_3 >, \dots, n_N > n_b, \text{ and } n_a > n_N$$

such that the refractive indices of the first and second SCH  
layers become smaller ~~the further away with increasing~~  
 25 distance from the active layer, ~~and including the relationship~~  
~~that the refractive index  $n_s$  of the active layer is the highest,~~



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~~and the refractive index  $n_a$  of the n-type cladding layer is higher than the refractive index  $n_b$  of the p-type cladding layer, and~~

30 ~~the refractive index differences between the indices of adjacent layers which are adjacent to one another~~  
in said plurality of layers respectively structuring the first SCH layer and the second SCH layer are set to ~~be the~~ satisfy a relationship:

35 
$$n_s - n_1 > n_1 - n_2 > n_2 - n_3 > \dots > n_{(N-1)} - n_N$$
  
such that the differences between the refractive index  
~~differences indices~~ become smaller ~~the further toward~~ with  
decreasing distance from the corresponding one of the n-type  
cladding layer and the p-type cladding layer and increasing  
40 distance from the active layer.

10. (Currently Amended) A semiconductor light emitting device according to claim 5, wherein, given that a refractive index of a layer having ~~the a~~ lowest refractive index ~~of said plurality of layers structuring in~~ the active layer is  $n_s$ , ~~the~~  
5 given that respective refractive indices and ~~the thickness~~  
thicknesses of said plurality of layers of the first SCH layer are ~~respectively~~  $n_1, n_2, n_3, \dots, n_N$  and  $t_1, t_2, t_3, \dots, t_N$ , an at  
order ~~close~~ increasing from the active layer, and given that  
respective refractive indices and ~~the thickness~~ thicknesses of

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10 said plurality of layers of the second SCH layer are ~~respectively~~  
n1, n2, n3, ..., nN and t1, t2, t3, ..., tN, in an ~~at~~ order ~~close~~  
increasing from the active layer,

~~the relationship of the magnitudes of the refractive indices~~  
of the respective layers of the active layer, the first SCH  
15 layer, the second SCH layer, the n-type cladding layer and the p-  
type cladding layer is set to be ~~the relationship~~ satisfy  
relationships:

$$n_s > n_1 > n_2 > n_3 > \dots, n_N > n_b, \text{ and } n_a > n_N$$

such that the refractive indices of the first and second SCH  
20 layers become smaller ~~the further away with increasing~~  
distance from the active layer, ~~including the relationship that~~  
~~the refractive index ns of the active layer is the highest, and~~  
~~the refractive index na of the n-type cladding layer is higher~~  
~~than the refractive index nb of the p-type cladding layer, and~~

25 differences between the refractive ~~index~~ differences between  
the indices of adjacent layers ~~which are adjacent to one another~~  
in said plurality of layers respectively structuring the first  
SCH layer and the second SCH layer are set to be ~~the~~ satisfy a  
relationship:

$$30 \quad n_s - n_1 = n_1 - n_2 = n_2 - n_3 = \dots = n_N - n_b$$

~~such that the refractive index differences are equal to one~~  
another, and

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~~the relationship of the thickness~~ thicknesses of the  
respective layers ~~is of both the first and second SCH layers are~~  
35 set to ~~be~~ satisfy a relationship:

$$t1 < t2 < t3 < \dots < tN$$

such that the ~~thickness becomes~~ thicknesses become larger the  
further ~~away with increasing distance~~ from the active layer.

11. (Currently Amended) A semiconductor light emitting  
device according to claim 5, wherein, given that a refractive  
index of a layer having ~~the a~~ lowest refractive index ~~of said~~  
~~plurality of layers structuring in~~ the active layer is  $n_s$ , ~~the~~  
5 given that respective refractive indices and ~~the thickness~~  
thicknesses of said plurality of layers of the first SCH layer  
are respectively  $n_1, n_2, n_3, \dots, n_N$  and  $t_1, t_2, t_3, \dots, t_N$ , an at  
order ~~close~~ increasing from the active layer, and given that  
respective refractive indices and ~~the thickness~~ thicknesses of  
10 said plurality of layers of the second SCH layer are respectively  
 $n_1, n_2, n_3, \dots, n_N$  and  $t_1, t_2, t_3, \dots, t_N$ , in an at order ~~close~~  
increasing from the active layer,

~~the relationship of the~~ magnitudes of the refractive indices  
of the respective layers of the active layer, the first SCH  
15 layer, the second SCH layer, the n-type cladding layer and the p-  
type cladding layer is set to ~~be the relationship~~ satisfy  
relationships:

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$$n_s > n_1 > n_2 > n_3 > \dots, n_N > n_b, \text{ and } n_a > n_N$$

such that the refractive indices of the first and second SCH layers become smaller ~~the further away with increasing distance~~ from the active layer, ~~including the relationship that the refractive index  $n_s$  of the active layer is the highest, and the refractive index  $n_a$  of the n-type cladding layer is higher than the refractive index  $n_b$  of the p-type cladding layer, and~~

differences between the refractive index differences between the indices of adjacent layers which are adjacent to one another in said plurality of layers respectively structuring the first SCH layer and the second SCH layer are set to ~~be the~~ satisfy a relationship:

$$n_s - n_1 > n_1 - n_2 > n_2 - n_3 > \dots, > n_{(N-1)} - n_N$$

such that the differences between the refractive index differences indices become smaller ~~the further away with increasing distance~~ from the active layer, and

~~the relationship of the thickness~~ thicknesses of the respective layers ~~is of both the first and second SCH layers are set to be~~ satisfy a relationship:

$$t_1 < t_2 < t_3 < \dots, < t_N$$

such that the ~~thickness becomes~~ thicknesses become larger ~~the further away with increasing distance~~ from the active layer.

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12. (Original) A semiconductor light emitting device according to claim 2, wherein the semiconductor light emitting device is formed so as to be a buried structure.

13. (Currently Amended) A semiconductor light emitting device according to claim 12, wherein the n-type cladding layer, the first SCH layer, the active layer, the second SCH layer, and a part of the p-type cladding layer are formed to be a mesa type, and the semiconductor light emitting device further comprises:

a first buried layer formed from p-type InP such that one surface thereof contacts one of the semiconductor substrate ~~or~~ and the n-type cladding layer at ~~the~~ both sides of the respective layers formed to be a mesa type; and

a second buried layer formed from n-type InP such that one surface thereof contacts the p-type cladding layer and the other surface thereof contacts the other surface of the first buried layer at ~~the~~ said both sides of the respective layers formed to be a mesa type.

14. (Original) A semiconductor light emitting device according to claim 1, wherein the semiconductor light emitting device is formed so as to be a ridge structure.

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15. (Currently Amended) A semiconductor light emitting device according to claim 14, wherein, when the semiconductor substrate is n-type, the p-type cladding layer ~~is formed as~~ comprises a ridge structured portion in which ~~the~~ a substantially central portion ~~at the of an~~ of an outer side thereof ~~is heaped to the upper side~~ extends outward farther than outer portions thereof, and the semiconductor light emitting device further comprises:

a contact layer formed at ~~the~~ an upper side of the ridge structured portion at the p-type cladding layer;

an insulating layer formed so as to ~~open the~~ expose a central portion of the contact layer, and so as to cover the p-type cladding layer including the ridge structured portion; and

an electrode formed at ~~the~~ a top portion of the insulating layer ~~in a state in which~~ such that one portion thereof is connected to the contact layer.

16. (Currently Amended) A semiconductor light emitting device according to claim 1, wherein a bandgap wavelength of InGaAsP structuring the n-type cladding layer is ~~less~~ not more than ~~or equal to~~ 0.97  $\mu\text{m}$ .

Claims 17 and 18 (Canceled).

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19. (Currently Amended) A semiconductor light emitting device according to claim 1, wherein, when the semiconductor substrate is n-type, the n-type cladding layer is formed at ~~the~~ a lower side of the active layer, and the p-type cladding layer is formed at ~~the~~ an upper side of the active layer.

20. (Currently Amended) A semiconductor light emitting device according to claim 1, wherein, when the semiconductor substrate is p-type, the n-type cladding layer is formed at ~~the~~ an upper side of the active layer, and the p-type cladding layer is formed at ~~the~~ a lower side of the active layer.